



***IR&D SUCCESS STORIES***  
***WITH INDUSTRY & NAVAIR***  
**Naval Industry R&D Partnership**  
**Pre-Conference Workshop**

**3 August 2004**

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# APPROACH

- **Interviews with Industry**

- NAVSTO interviewed representatives from:

- **Lockheed Martin**
    - **General Electric**
    - **Northrop Grumman**
    - **Boeing**
    - **Raytheon**
    - **Bell Helicopter Textron**
    - **Arete Associates**
    - **ALPHATECH**
    - **FLIR Systems, Inc.**

- The information presented from each company is unclassified and has been cleared for public release by the respective companies

- **Interviews with NAVAIR Acquisition Program Management Offices**

- NAVSTO interviewed personnel from: E-2/C-2, Standoff Missile Systems, Air-to-Air Missiles, F/A-18 and H-1 Upgrades

# APPROACH

- **IR&D Success Stories Database**

- A reserve Officer created a database of NAVAIR IR&D success stories during his active duty with NAVSTO in 2002
- NAVSTO will maintain and add to this database, presenting final results to ONR at the end of each fiscal year should funding be allocated

- **Technology Expositions**

- Feature displays and exhibits by companies in the atrium of NAVAIR headquarters building in concert with proprietary technical presentations in conference rooms
- Revised procedure and process for Technology Expos is being developed since the leadership of the current NAVAIR SYSCOM Commander, Admiral Massenberg

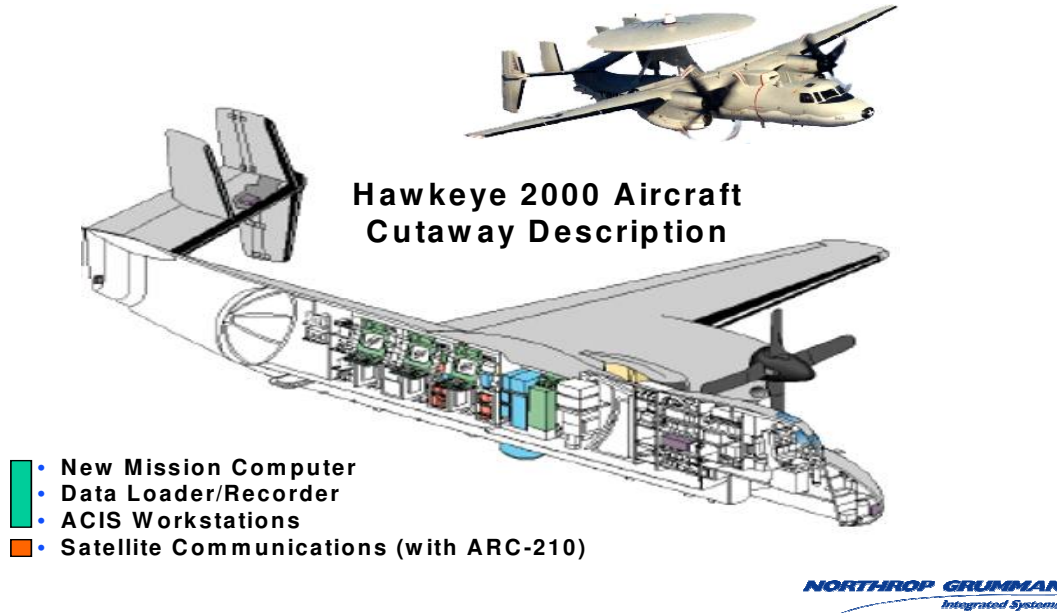
- **IR&D Workshop**

- IR&D workshop conducted for NAVAIR S&E's in March 2003
- Defense Technical Information Center's (DTIC) Dave Hyman briefed all aspects of the DOD IR&D program and a demonstration on the DOD IR&D database

# RESULTS

## NORTHROP GRUMMAN CORPORATION

### E-2C Capabilities Improvement Program (CIMP)

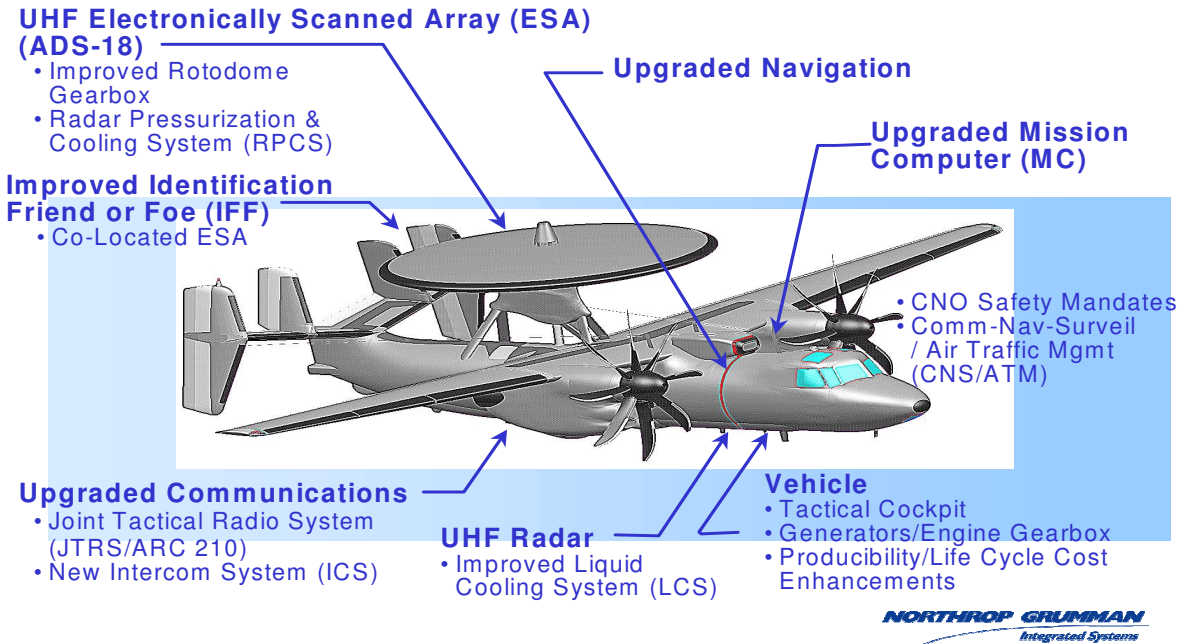


- The Mission Computer Upgrade (MCU), yielded significantly improved performance with an affordable and supportable commercially based architecture
- The E-2C SATCOM implementation CIMP IR&D, provides over-the-horizon voice communications for the Hawkeye
- MCU and SATCOM voice were approved for low-rate initial production (LRIP) and later approved for full-rate production as part of the current Hawkeye 2000 configuration

# RESULTS

## NORTHROP GRUMMAN CORPORATION

### AEW Surveillance Platform / Advanced Hawkeye Configuration



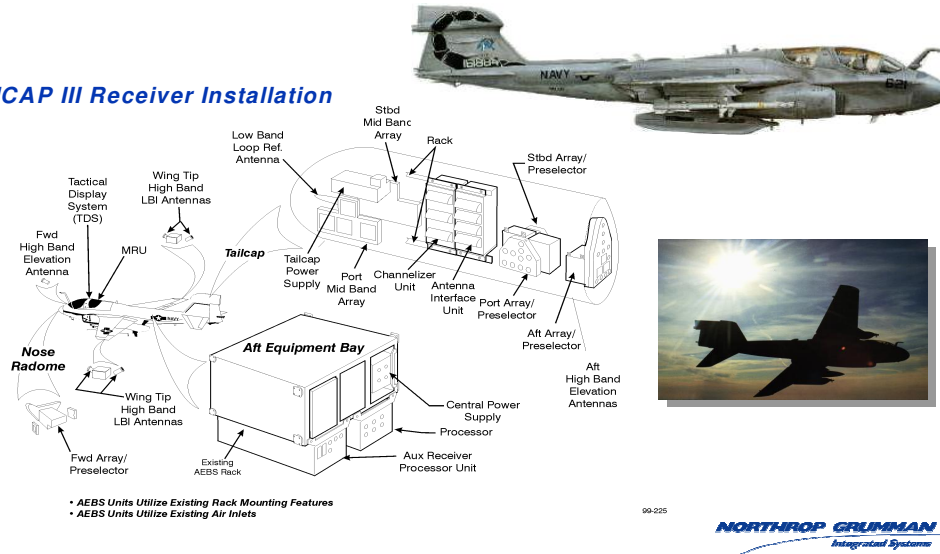
- Objective is to improve 360 degree AEW over-water, over-land and littoral surveillance capability
- These company funded activities led to various contracted development efforts to support technology maturation and demonstration
- Low level efforts began over 15 years ago, funding has increased over time; NGC Integrated Systems, NAVAIR PMA-231 and ONR

# RESULTS

## NORTHROP GRUMMAN CORPORATION

### EA-6B ICAP III Receiver Development

#### ICAP III Receiver Installation



- The results of this project led directly to the Navy's adoption of the "selective reactive" jamming concept, as implemented in the EA-6B ICAP III program, which is currently in the final stages of development and nearing transition to the fleet
- It also provided response time requirements used for the LR-700 receiver subsystem that is a core element of the ICAP III system

- Navy selected the NGC ICAP III system as the baseline for the follow-on support jammer (FOSJ)
- Internally funded efforts produced multiple variants of the NGC LR-700 based ICAP III system
- Entered the funded pre-SD&D phase in October 2002, with the SD&D expected to begin in January 2004
- Air Force also considering this technology to develop a standoff support jamming capability

### FOSJ / EA-18G Configuration



**NORTHROP GRUMMAN**  
Integrated Systems

# RESULTS

## ARETE ASSOCIATES

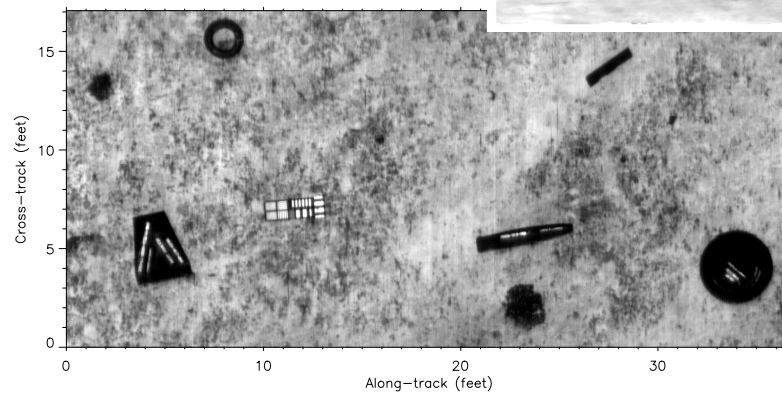
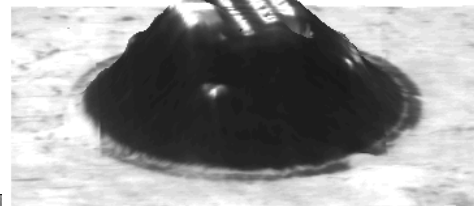
- Small business located in Arlington, VA
- Developed and patented a 3-D imaging system, laser based and now widely used for electro-optical identification
- Arete is now under contract with NAVAIR to design, fabricate, integrate and flight-test a helicopter borne system that will provide a high rate search capability for the detection of surface and shallow-moored mines

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### Ocean Demonstration of STIL for Mine ID

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Perspective view of Manta mine generated from 3-D STIL data



Bottom contrast  
Image (45' depth)

Areté Associates



# RESULTS

## BELL HELICOPTER TEXTRON, INC.

Zulu One  
or AH 1A 1



- Bell Helicopter Textron has invested ~\$70m in IR&D over the last 5 years on military programs, e.g. V-22, H-1 and UAVs
- Zulu One is a technology demonstrator constructed completely with company IR&D dollars – used for initial flight testing
- Identified issues with vibration, performed a study on IR aircraft signature



# RESULTS

## FLIR SYSTEMS, INC.

- FLIR Systems, Inc. (FLIR), of Portland, Oregon, began a unique relationship with the Marine Corps during Operation Desert Storm
  - **Borrowed two of their Model 2000 systems**
  - **Were used in an operation that merited the only Navy Cross of the war**
- FLIR continued develop Model 2000 leading to BRITE Star system
  - **FLIR fully funded the development effort and delivered a finished product to the NAVAIR customer**
  - **Live fire tests conducted at MCAS Yuma from March 2002**
  - **Two Hellfire missiles were shot from an AH-1W, two direct hits resulted with the BRITE Star on the UH-1N providing laser designation**
  - **Company investment in BRITE Star was between \$5 million and \$10 million**
  - **BRITE Star system was recently installed on the Hairy Buffalo time-critical targeting test bed configuration**

# RESULTS

## RAYTHEON

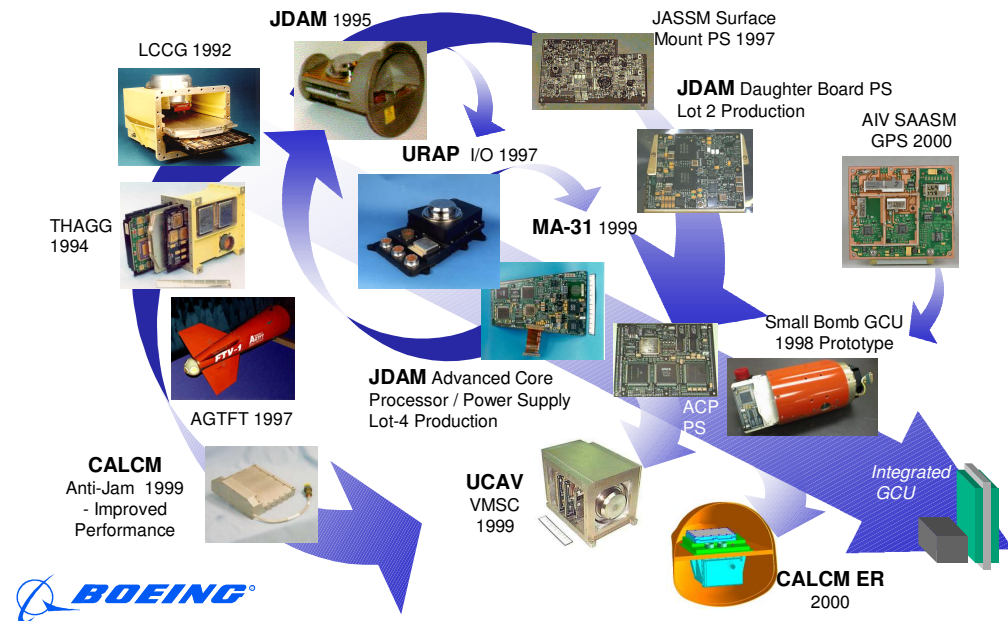
- **Active Electronically Scanned Array (AESA)/AIM-9X:**
  - *Heavy IR&D investment in the development and transition of the APG-79 AESA radar for the F/A-18E/F*
  - *Total IR&D investment in the AESA program exceeds \$30 million*
  - *IR&D was used in the development process for the following:*
- **HTM4 TR Module Development and Producibility:** Designed, fabricated, and tested next generation high performance tiled TR module for application to a wide range of active array programs, including AESA, RTIP, and others.
- **Compact Tile Array:** Developed and tested high performance tile active array for application to a wide range of active array programs, reduced weight, advanced packaging, and high performance.
- **Receiver/Exciter (REX):** Developed a next generation receiver/exciter with advanced capabilities. Technology includes development of DDS and ADC.
- **Platform Independent Operational Flight Program (OFP):** Developed the platform independent software for the AESA application. This software is targeted for a wide range of platforms.
- **Network Interface Controller (NIC) in Common Integrated Sensor Processor (CISP):** Developed firmware to perform fiber channel protocol. IRAD has broad application across CISP based product lines.

# RESULTS

## THE BOEING COMPANY

- **Joint Direct Attack Munition (JDAM):** Enabled by IR&D that developed low-cost core guidance in the early 1990's. GPS satellite all-in-view and advanced core processor IR&D are already adopted by JDAM
- **HyFly:** Phantom Works co-invested via IR&D in the dual-combustion ramjet portion of the DARPA ARRMD 845 agreement beginning in June 1998, and refined the design of this hypersonic flight demonstrator under IR&D in 2001 and 2002, leading up to the DARPA/ONR HyFly award
- **SLAM-ER:** Phantom Works IR&D work on automatic target recognition and general pattern match algorithms has been adopted
- **UCAV-N, Universal Replacement Autopilot (URAP) for Navy Targets, MA-31 Target:** Low-cost core guidance and advanced core processor IR&D have been applied

### Boeing Phantom Works Exploits Tactical Guidance Technology Trends Through IRAD To Win New Programs and Benefit Other Boeing Programs



# RESULTS

## THE BOEING COMPANY

- **F/A-18A/B/C/D:** *Boeing IR&D investment in the F/A-18A/B/C/D includes the following:*
  - APG 73 Radar (Radar Upgrade Program): provided increased processing power and provided an upgraded receiver/exciter. These improvements provide capability growth and enhanced reliability and maintainability.
  - Departures Resistant Control Law Upgrade: The departure resistant control law upgrade, also referred to as Beta ~~at~~ feedback, offers improved departure resistance to the F/A 8, improving flight safety
  - ALE 47: The ALE- 47 countermeasures dispenser set provides the capability for autonomous deployment of countermeasures. It also allows the use of advanced countermeasures. The benefit to the aircraft is improved survivability.
  - Enhanced Performance Engine (EPE): Boeing and GE fully funded the development and integration of the enhanced performance engine, a modified F404 ~~E~~ 400. The F404 ~~GE~~ 402 (EPE) provides an increase in thrust of 10% over the previous F/A- 18 engine. The benefit to the F/A 18 is enhanced flight performance.
  - On board Oxygen Generating System (OBOGS): Boeing and Litton funded concept feasibility, trade studies, and risk reduction studies prior to Navy funding of the development program, enables the elimination of liquid oxygen

# RESULTS

## THE BOEING COMPANY

- **F/A-18E/F:** *Boeing IR&D investment in the F/A-18E/F includes the following*
  - APG 79(AESA) Radar: The APG 79 radar has two to three times longer detection range compared to APG- 73, tracks over 20 targets simultaneously, and can produce high resolution maps at greater than 50 nautical miles. The benefits to the aircraft are greater air to air and air to surface lethality, and improved survivability. The APG- 79 also provides improved reliability, thus reducing operating and support cost.
  - Advanced Targeting Forward Looking Infrared (ATFLIR): The ATFLIR has a detection/recognition range two to three times longer and a higher operating altitude than the previous generation FLIR. The benefits to the aircraft are greater air to surface lethality and improved survivability.
  - Design, Manufacturing, Producibility Simulation (DMAPS): An integral part of the DMAPS process is the use of virtual manufacturing (VM) to assess impacts to manufacturing early in the design process. Effective use of VM ensures that the product definition is correct before significant investments are committed for production.
  - Advanced Crew Station: The advanced crew station program enables crewmembers to perform independent functions/missions simultaneously. It also provides a large display that aids in the performance of precision strike and planned electronic attack missions. The benefits to the aircraft are greater air to air and air to surface lethality, and improved survivability.
  - Joint Helmet Mounted Cueing System (JHMCS): Boeing, Kaiser, and Elbit funded concept feasibility, trade studies, and risk reduction activities, including flight demonstrations, prior to Navy/international funding of the development program. Boeing identified potential issues, risks, and technology evolutions to be pursued. The joint helmet mounted cueing system provides off bore sight visual cueing of weapons and sensors.

# RESULTS

## INTEGRATED HIGH PERFORMANCE TURBINE ENGINE TECHNOLOGY (IHPTET) PROGRAM

- The IHPTET program is a joint Air Force, Navy, Army, Defense Advanced Research Projects Agency (DARPA), National Aeronautics and Space Administration (NASA), and industry effort focused on developing technologies for more affordable, more robust, higher performance turbine engines
- Industry partners in IHPTET are General Electric, Pratt & Whitney, Rolls Royce (Allison Advanced Development Company), AlliedSignal, Teledyne, and Williams
- Funding for the IHPTET initiatives equals 50% from government 6.2 and 6.3 funding, with the remaining 50% contributed from industry research and development monies

	Phase I	Phase II	Phase III
<b>Turbofan/Turbojet</b>			
<b>Thrust/Weight</b>	30%	60%	100%
Combustor Inlet Temperature	100°F	200°F	400°F
Production Cost		-20%	-35%
Maintenance Cost		-20%	-35%
<b>Turboshaft/Turboprop</b>			
<b>SFC</b>	-20%	-30%	-40%
Shaft Horsepower/Weight	40%	80%	120%
Production Cost		-20%	-35%
Maintenance Cost		-20%	-35%
<b>UAV/Expendable</b>			
<b>SFC (Strategic)</b>	-20%	-30%	-40%
Thrust/Airflow	35%	70%	100%
Production Cost	-30%	-45%	-60%

IHPTET is now ready to demonstrate Phase II goals and is on track to demonstrate 90% of goals by 2005

# RESULTS

## HAIRY BUFFALO (SMART PLANE)

- The Hairy Buffalo serves as the Navy's first "smart plane," built for efficiency in the network-centric warfare RDT&E arena
- Lockheed-Martin Aeronautics Company invested IR&D for fiber optic wave division multiplexing
  - **The patented fiber optic bus with wavelength division multiplexing (FOBWDM™) is an extremely high bandwidth, low cost, highly reliable, inherently secure, bi-directional transmission of light at a single wavelength WDM, multi-hop, multi-topology area network**
- Northrop Grumman contributed X-band APY-6 radar
  - **Adapted from the E-8 Joint STARS ground surveillance radar**
  - **Although this radar was an ONR-funded effort, a significant amount of company IR&D was invested as well providing moving target indication (MTI) capability**
  - **The MTI simultaneously collects and displays images of the terrain and structures with overlays that show moving targets**
  - **Hairy Buffalo is the only Navy aircraft flying with the MTI capability**
- ALPHATECH developed the first version of the DM++ software product
  - **Enables visualization of ground moving target indicator (GMTI) radar data, including raw reports and target track data**



# RECOMMENDATIONS

- **Collaboration of efforts and investments among:**
  - Industry IR&D
  - Government research agencies
  - System Program Offices
- **Define requirements for PMA funding for transition**
  - Funding to support a 'Transition Roadmap' would support prioritization of Contract R&D and IR&D investment decisions
- **Experimentation**
  - Need improved linkage between the operational, requirements and acquisition communities (e.g. Fleet Forces Command, OPNAV and SYSCOM) to shape future exercises and act on their key lessons learned
- **Prime Involvement**
  - Technology or capability transition implies implementation within a system (or system-of-systems) provided by a systems integrator
- **Broader use of the DTIC IR&D database**

# SUMMARY

- **NORTHROP GRUMMAN CORPORATION**

- E 2C Hawkeye Capabilities Improvement Program (CIMP)
- E 2C Hawkeye AEW Surveillance Platform/Radar Modernization Program
- EA 6B Advanced Receiver Development
- EA 18G Follow On Support Jammer
- Advanced Diagnostics and Prognostics Technology
- Airborne Mine Countermeasures (AMCM) Technology
- F/A 18E/F Materials and Manufacturing Technology Development

- **ARETE ASSOCIATES**

Electro-Optic Airborne System (EOS 1) for Mine Detection

- **BELL HELICOPTER TEXTRON, INC.**

- H 1 Upgrades Program

- **FLIR SYSTEMS, INC.**

- H 1 Forward Looking Infrared (FLIR) System (BRITE Star)

# SUMMARY

- RAYTHEON
  - Active Electronically Scanned Array (AESA)/AIM-9X
  - Affordable Modular Digital Receiver (AMDR)
- THE BOEING COMPANY
  - Advanced Tactical Missile Systems
  - F/A 18A/B/C/D
  - F/A 18E/F
  - F/A 18Derivatives
- INTEGRATED HIGH-PERFORMANCE TURBINE ENGINE TECHNOLOGY (IHPTET) PROGRAM
- HAIRY BUFFALO (SMART PLANE)